STATE & PRIVATE FORESTRY
FOREST HEALTH PROTECTION
SOUTH SIERRA SHARED SERVICE AREA

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From: State and Private Forestry, Forest Health Protection, South Sierra Shared Service Area

Subject: Current bark beetle activity and mortality assessment
Cold Springs Forest Health and Restoration Project, 2017
Mi Wok and Summit Ranger Districts, Stanislaus National Forest

2017 Cold Springs Healthy Forest Restoration project is proposed under the 2014 Farm Bill to reduce and prevent the incidence of forest pests, restore natural processes within historical regimes, and remove hazardous trees that pose threats to public safety and infrastructure. The Middle South Fork Stanislaus River and Upper North Fork Tuolumne River are designated watershed that meets the 2014 Farm Bill criteria where there have been and is expected to be increased pest activity (25% basal area lost) over the next 15 years based on National Insect and Disease Risk Map (see Appendix A). The project area has experienced significant mortality due to bark beetles and drought effects since 2012 with new trees continuing to fade this year. The project covers 2520 acres of general forest, wildland interface, main FS roads, and powerline accessibility. This report documents observations noted in ground and aerial surveys, providing management discussion on proposed treatments and outcomes.

Introduction

On July 26, 2017, Beverly M. Bulaon (entomologist, Forest Health Protection (FHP)) joined in an Interdisciplinary Team meeting to view the 2017 Cold Springs Healthy Forest Restoration project, Mi Wok and Summit Districts, Stanislaus National Forest (Sec 1-2, T3N R17E; Sec 4-8, T3N 18E; Sec 24-27, 34-36, T4N R17E; Sec 15-21, 28-31, 24-34, T4N 18E; Sec 15-21, T4N 19E)(*Cold Springs Public Scoping Document, July 10, 2017*). Several stops at varying units were made to discuss potential treatments and concerns regarding objectives and outcomes. The project is primarily focused on three main objectives:

- Removal of hazard trees to provide for public and infrastructure safety along main roads, around structures, property boundaries
- Reduce potential for catastrophic wildfire by reducing fuel loads near the community of Cold Springs
- Reestablish a healthy, mixed conifer forest that contributes to an ecologically resilient landscape

Most of the proposed project area sits in the 4000-6000 feet elevational range, mixed conifer forest type. There is the large community of Cold Springs that sits on the southern side of Highway 108 (southwest corner), several privately run outdoor camps, and some smaller private land ownerships intermixed within the project boundary. Much of the project will be hazard tree removal along pertinent roads, with prescribed burning in three units.

Observations

Annual aerial detection surveys (ADS, 2012-2017 Forest Health Monitoring) show mortality associated with bark beetles starting in 2012. South face slopes and along the ridge tops have suffered the worst, previously treated or not. Lava cap soils had many dead trees of all size classes and species. Early mortality was primarily in pine-dominated forest type, although current mortality has been in white firs and incense cedars. In 2013-2015, pine mortality was more scattered but groups were observed as high as 30-100 trees per acre, over 100 acres (see Figure 1). Current pine mortality is about 3-10 trees per acre with much of this mortality around the edges of older dead pockets or singular sugar pines. Early 2017 flights show mortality in white fir was noted at 10-15 trees per acre. Polygons that recorded both pine and fir mortality noted up to 25 dead trees per acre. There was also a considerable amount of white fir and incense cedar sapling/small tree mortality that is not visible from ADS but observed in ground surveys.

Figure 1. *Ponderosa pine mortality along northwest facing slope of the Middle South Fork Stanislaus River. This mortality was grouped in older pine plantations, estimated 2015 attack.*

Bark beetle activity has been active around private homes and wildland-interface, particularly western pine beetle infesting Ponderosa pines.   Ground surveys conducted by FHP in August 2017 found tree mortality has been most severe in older pine plantations, where tree diameters averaged 15-20 inches diameter at breast height (DBH).   Regardless of past treatments, bark beetles killed up to 90% of trees in these plantations – especially when tree diameters were large (see Figure 2).   In younger plantations (DBH 8-10 inches), recent ~2016 activity due to a combination of western pine beetle, pine engravers, and red turpentine beetles was observed.   These patches were smaller in size (10-20 trees/group), but still scattered throughout the larger plantation with potential to increase as some trees were only top-killed by pine engravers.   Most of the mortality in pines is estimated to have occurred in the past two years, with large polygons estimated of up to 100 trees dead.

Figure 2. *Nearly 100% ponderosa pine mortality in an older plantation, northwest facing slope. All trees infested by western pine beetle.*

Sugar pines have been declining for the past decade – observations in Cold Springs were characteristic of the mortality happening throughout the Sierra Nevada. Moderate to old-growth trees are killed by a combination of bark beetles and white pine blister rust (WPBR, *Cronartium ribicola*) (see Figure 3); or smaller saplings are stem-girdled by other native insects feeding on bole cankers caused by WPBR. Trees greater than 30 inches were often observed with beetle galleries under the bark, killed more than 3 years previously. Mortality typically appears a mass attack combination by mountain pine beetle and red turpentine beetle. Heavy pitch streaming was often seen on declining green trees in upper bole, eventually covered with pitch tubes due to continuing attack. Stand density does appear to have contributed to higher probability for infestation: dead sugar pines were notably intermixed or nearby other groups of trees also killed by bark beetles. High basal area (>220 ft2/ac) appear to be a good susceptibility predictor for sugar pines to insect infestation in this project.

Figure 3. *Singular large diameter sugar pine killed ~2015 by mountain pine beetle.*

Incense cedar mortality was not detected in earlier years of the current drought, but was more evident this past year throughout lower elevations of Stanislaus NF. Incense cedars of all size classes were noticeably fading and quickly losing foliage despite heavy precipitation this past winter. Along road 4N14, high mortality in all trees was observed (see Figure 4). No insect or pathogen were found in significant numbers to attribute to decline in cedars, suggesting that mortality here was due to soil type and drier conditions along the ridge. Dead mature cedars in other areas were noted with scattered woodborer activity under the bark, but no definitive mortality agent determined. Where mortality has been often been observed in the Sierras is at low elevations where cedars may be at the edge of range limits, or in extremely dense stands where several species of trees are also dying most likely due to competition.

Figure 4. *Recently dead trees along Road 4N14; ponderosa pines in the foreground, incense cedars in the background.*

Walking through several different treatment areas in the project, mortality or damage in white firs has significantly increased in 2016 and 2017. Not all trees were dead – particularly larger diameters where crowns were partially red, dying in varying patterns throughout the crown. Mortality appeared to have similar characteristics regardless of location, stand density, or elevation. First, all size classes were found affected by some insect along the bole or around the base – some successful with galleries, some ejected leaving behind abundant pitch streamers. Engraver beetles, wood borers, ambrosia beetles, and some secondary insects were found, but not consistently associated with pitch streaming or boring dust. Dense fir engraver (*Scolytus ventralis*) galleries were detected on larger trees, mingled with woodborer galleries in the lower bole. Second, grouped mortality was very much characteristic of root disease centers: older dead snags with progression of declining dead moving outward of the center (see Figure 3). Signs and symptoms associated with *Heterobasidion occidentale* were most pervasive in prescribed burn units wherever group kills of true fir and previous logging activity coincided. Old flush cut stumps were noted with *Heterobasidion occidentale* conks inside or laminated wood decay along the bole.

Figure 5. *Characteristic pocket of dead and declining white fir radiating from the center is indicative of Heterobasidion occidentale root disease.*

Pest and Management Discussion

Despite abundant rainfall this past winter and spring, trees in the Sierra Nevada are still recovering from severe drought effects; thereby still susceptible to infestation by bark beetles. Western pine beetle activity overall does appear to have subsided based on the lower numbers of currently infested ponderosa pines, and can be expected to continue to decline if precipitation remain at or above normal for the next few years. Native bark beetles will respond quickly if weather conditions revert to drier conditions. Several studies cite strong correlation of lower-than-average precipitation years as triggers of bark beetle-caused mortality in the Sierras (Ferrell et al. 1994, Guarin and Taylor 2005, Oblinger et al. 2011). The combination of prolonged, severe drought creating abundant host material has contributed to widespread bark beetle-associated mortality. If stand conditions persist that are attractive to bark beetles, regardless of weather, mortality will continue.

Ponderosa pines in California are primarily attacked by western pine beetle (*Dendroctonus brevicomis* Hopkins, WPB) (DeMars and Roettgering 1982). WPB is highly mobile seeking out weakened, diseased, or decadent trees. As mentioned previously, populations can build rapidly when environmental conditions are favorable for growth and expansion. Hayes et al. (2009) determined that altering basal area or stand density index (SDI) is critical to reducing WPB susceptibility but should implemented over large areas to be effective. Therefore, prevention strategies regarding this beetle should be applied at landscape scales wherever possible. Oliver's (1995) SDI standard at 230 (if maximum is 365) for ponderosa pine dominated stands is the

onset at which potential beetle-associated mortality is low, but lower SDI may be warranted if situations exist that may still contribute to high risk (Hayes et al. 2009).

Reducing fuel loads and hazardous conditions can be accomplished with treatments that serve dual purpose, but reducing susceptibility to bark beetles may require different actions. Stand densities below eminent mortality thresholds (Oliver 1995) for bark beetles are typically much lower or altogether different than fuel reduction treatments (Fettig and Hilszczanski 2015). Dead tree removal may alter stand structure and composition dramatically – especially if overstory trees are dead -- but unless critical thresholds are met, vulnerability to insect infestation still exists (Fettig 2012). Selecting only smaller diameter trees minimally prevents attraction, as beetles often choose larger diameter hosts initially. Similar recommendation applies to prescribed burning: moderate to severe injury on live trees that reduces vigor weakens tree defense mechanisms against incoming beetles, resulting in additional mortality (Fettig et al. 2007). Proposed treatments of prescribed fires and hazard tree removal will reduce some resource competition in targeted areas, but failure to reduce down to low risk thresholds perpetuate conditions that are still highly susceptible to attack.

As with many areas in the Sierra Nevada, past management practices in mixed conifer stands did not account for the future pervasiveness of native root diseases *Heterobasidion occidentale* or *H. irregulare*[1]. *H. occidentale* infects true firs and hemlock, *H. irregulare* favors pine. Both of these cause severe rot of the roots and butt of host trees. It has become more widespread in California in mixed conifer stands that have had previous logging (Scharpf 1993). This pathogen spreads by spores landing on freshly injured wood or through root-to-root connections underground. It is commonly overlooked and not considered significant as a disturbance agent in western forests, despite its long-term persistence and effects in the stand. The prevalence of this pathogen in this project and many other locations where true firs dominate in the Sierras should be a concern regarding future forest conditions. Trees infected with predisposing agents such as *H. occidentale* make them more susceptible to inciting and contributing factors (ex: bark beetles) that ultimately lead to their death (Manion and Lachance 1992). Fir engraver-associated mortality is often located where *H. occidentale* disease occurs (*personal observation*), spiking during drought events.

<u>Conclusion</u>

Public safety and prevention of catastrophic wildfires is imperative due to the significant amount of dead trees and proximity of wildland interface. Once trees are dead (bark beetles or otherwise), fall rates are highly unpredictable, therefore the potential risk for injury or damage is high. Hazardous trees should be removed quickly, or areas cordoned off if hazardous conditions remain until treated. While walking through heavy mortality areas in Cold Springs project, personnel should be very cognizant of tree failure risk[2]. In the Rocky Mountains, bark beetle-killed trees created variable fuel load phases as trees deteriorate over time (Jenkins et al. 2014, Hicke et al. 2012); but assessing potential burn severity in California is still early stages of research. Nonetheless, bark beetles considerably affect fuel structure and fire behavior compared to unattacked stands,

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[1] *Formerly a singular species as H. annosum but with a P-type (pine type) and S-type (fir type). Separated as two distinct species by Ortosina and Garbelotto 2010*.

[2] Questions regarding categorizing hazard trees, please refer to *Hazard Tree Guidelines for Forest Service Facilities and Roads in the Pacific Southwest Region (approved April 2012, Angwin et al. 2012)* contact Forest Health Protection.

thereby their potential effects should be integrated when planning future wildfire prevention treatments (Hicke et al. 2012).

While bark beetle mortality in some areas may appear devastating, western forests experience natural disturbances at varying scales. Insects and diseases are natural disturbance agents that create gap openings by thinning trees, provide forage, and recycle biomass. Re-establishing healthy forest conditions does not suppress natural biological process, but allows changes to occur within historic ranges of variability (HRV). Tree mortality associated with bark beetles often occur at small stand scales at background levels, but if optimal conditions for growth arise, insects will respond rapidly. Management can focus on reducing *the potential* for high levels of mortality, but drought events affect host trees over large landscapes that many locations are susceptible to attack leading to exponential growth for beetles (Raffa et al. 2008). Creating forests that are heterogeneous at varying scales can mitigate mortality from occurring over large landscapes (Fettig 2012).

As true firs are becoming more predominant and climate patterns are changing in western forests, this disease and others – including non-natives – are becoming more prevalent and strongly contributing to larger landscape dynamics. Mitigation of a wider distribution in currently infested or establishment in non-infested stands is prudent to keep overall mortality at background levels or retaining trees where values are high (ex: campgrounds). The use of registered borate compounds on freshly cut stumps (pines and firs) is strongly recommended to reduce the incidence of root disease. Treatments do not control established disease centers, but reduce the dissemination for new infection centers. Identified disease centers can be ideal for re-establishing non-host species if appropriate for the sites.

Restoration efforts to make forests that are resilient and resistant to current and future disturbances should especially consider other mechanisms (native insects and diseases) that create changes on the spatial and temporal scales. Especially with changing climate, biological interactions become more tightly linked. Native pest effects which can drive significant vegetation change need to be included in climate modelling (Anderegg et al. 2015). Native bark beetles can erupt to outbreak levels when conditions are optimal for population growth and dispersion, but also continue to make smaller changes in forests that are beneficial and necessary for forest health. Native diseases should not be overlooked when planning for forest health resiliency as their presence can alter resulting desired conditions for the long-term.

If there are any questions or concerns regarding this report, please do not hesitate to contact FHP.

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Appendix A. National Insect and Disease Risk modeling of Cold Springs Project area, August 2017. NOTE: used only top five most frequently encountered insect/diseases for this project.